

Serial No.: 10/554,480

Declaration of Paul F. Ierymenko in Support of Second Preliminary Amendment



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/554,480

Confirmation No.:

Applicant: Paul F. Ierymenko

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Title: A PLAYER TECHNIQUE CONTROL SYSTEM FOR A STRINGED INSTRUMENT  
AND METHOD OF PLAYING THE INSTRUMENT

**DECLARATION OF PAUL F. IERYMENKO IN SUPPORT OF SECOND  
PRELIMINARY AMENDMENT**

I, Paul F. Ierymenko, the inventor of the subject application (“‘480 application”), hereby  
declare as follows:

This declaration follows the statement that I submitted to the International Preliminary  
Examining Authority with the references to the claims changed to correspond to the new claims now  
in this ‘480 application.

The International Preliminary Report on Patentability dated November 3, 2005 concluded  
that claims 1-50 of my PCT/US04/18072 application (“‘072 application”) lacked novelty or were  
anticipated by the Ludwig U.S. Patent No. 6,852,919 (Ludwig patent or Ludwig”) relying on Col.  
74, lines 1-10 and Col. 3 lines 8-30 on the grounds that Ludwig discloses at least one transducer  
(2002) which can sense string motion, effect a change in the string motion, a supervisor for  
extracting features from the sensed string motion, and recognizing one or more preselected player

techniques and a controller responsive to the recognized technique(s) for applying an actuating signal to the transducer to modify the string's motion. In addition, the report, in citing Col 36, lines 40 through Col. 37, line 16, indicated that Ludwig discloses a sensing/actuating transducer capable of producing a sensing signal and respond to actuating signals during separate portions of successive time frames. The report further indicated that Ludwig teaches vibrato and glissando as preselected player techniques.

The Ludwig patent, in its 84 columns of text and 72 figures, broadly discloses numerous suggested circuits (in block form) for possible use with musical instruments including guitars. As a result of the report and the cited reference, I have revised my claims to focus on the aspects of my invention which represent a significant advance in the art including even a very generous reading of Ludwig. These aspects include (1) a true motion control in contrast to controlled feedback as employed in prior art sustainers such as taught in Ludwig, (2) use of a unitary sensing/actuating transducer in stringed instrument control systems, and (3) extraction of vibrato or glissando, as specific player techniques independently of true motion control.

The new independent claims, except for claims 148 and 149, while somewhat broader in certain respects than the original claims, call for a motion controller in apparatus (claim 99) or method (claim 138) terminology capable of damping and/or exciting the vibratory motion of the string in response to the actuating signal. This language distinguishes over the sustainer type system suggested in Ludwig. The dependent claims are generally comparable to the original dependent claims with certain claims broadly defining the transducer arrangement and other claims specifically calling for a unitary sensing/actuating transducer. Independent claims 148 and 149 are directed to

the use of vibrato and glissando as the specific player techniques to which the system is responsive. The subject matter covered by the claims is not taught nor suggested in Ludwig as will be pointed out. Unfortunately the broad and unfocused treatise of the Ludwig patent, the interpretation thereof by the author of the report, and the value I place on my invention have necessitated a somewhat lengthy discussion on my part. My qualifications for the following analysis set forth at Exhibit A attached hereto.

Motion Control versus Controlled Feedback (Sustainers):

A progression of this technology began with musicians experimenting with loud volumes and the incidental acoustic feedback that resulted. Observing this, inventors developed the use of deliberate acoustic and mechanical feedback. See my U.S. Patent No. 3,813,473 (“473 patent” wherein my name is misspelled with a T). The next improvement was direct electromagnetic feedback to the string. See U.S. Patent Nos. 4,075,921, 4,907,483, 5,200,569 and 5,233,123. This current state of the art, conventionally called a “sustainer”, is taught in the Ludwig patent, (but is called “controlled feedback” therein), and still has many deficiencies and problems.

In my present invention I introduce the novel concept of motion control of vibrating strings, which overcomes virtually all of the deficiencies and problems of the prior art. I also introduce the novel combination of motion controlled strings and a user interface that employs player technique recognition to render player techniques as commands to the motion controllers, such commands may take the place of manually activated switches and dials. I believe motion control of the strings of a musical instrument is not anticipated anywhere and further the combination of motion control with player technique commands is not anticipated.

To stabilize a motion control system requires exact knowledge and precise alignment of all phase relationships in the system and this is particularly challenging when controlling musical instrument strings since many mechanical parameters of a string change rapidly as the player plays upon it.

Adaptive loop stabilization is one method of stabilizing such a motion controller. One embodiment of my invention utilizes this adaptive stabilization method of motion control. Another embodiment of my invention uses the motion control system described in my U.S. Patent No. 6,216,059 (“‘059 patent”), i.e., a unitary sensing/actuating transducer. This system provides a novel means of achieving the needed precise alignment of all phase relationships in the system without the need of an adaptive filter and is thus well-suited to controlling string vibration. Both embodiments are claimed.

A string motion controller is a servo capable of suppressing specific motion or vibration and of promoting specific motion or vibration. Controlled feedback as shown in Ludwig and sustainers in general do not meet these criteria.

In Ludwig’s “controlled feedback”, feedback is being controlled to modify string vibration. However – and this is crucial – the motion of the string itself is not being controlled. In fact, any sustainer and controlled feedback as presented by Ludwig does the opposite: It is intentionally an unstable oscillatory system, a feedback loop that is deliberately out of control. Ludwig shows many means and methods of altering the feedback and undoubtedly all these will influence or modify string vibration, but none shown will suppress string vibration and none will stabilize the control loop. A stable control loop is a unique property of a motion control system that Ludwig does not anticipate.

Controlled Feedback Sustainer:

- Promotes vibration inexactly.
- Inhibits vibration only accidentally.
- No exact selection of harmonics.
- Changes vibration slowly<sup>1</sup>.
- Operates with mostly positive feedback.
- No prescriptive reference input.
- Intentionally an unstable system.

Motion Controller:

- Promotes vibration precisely.
- Inhibits vibration precisely.
- Controls selected individual harmonics.
- Changes vibration quickly and precisely.
- Operates with mostly negative feedback.
- Has prescriptive reference.<sup>2</sup>
- System maintains stability.

Using my invention of motion controlled strings the player can promptly excite or suppress any or all harmonics of vibration upon any string of his instrument by issuing a player technique, i.e., at will. One aspect of my invention adjusts the timbre of a note towards a reference that prescribes the timbre; another aspect suppresses vibration on strings that the musician does not intend to play. My invention does all this selectively, i.e., at will and with precision. The Ludwig patent anticipates none of this.

Through further recent searches of the USPTO database I have found U.S. Patent No. 6,320,113 (“113 patent”) that shows a true motion control system deployed on the body of an instrument for controlling the acousto-mechanical resonance of the body. This patent represents the

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<sup>1</sup>With a sustainer changes in timbre result from different frequencies and phases of energy being added to the system but since there is no means of quickly removing energy from the system such changes tend to occur over a longer time than the average duration of a musical note. This has limited usefulness in practical musical applications.

<sup>2</sup>The reference input to a motion controller may not be explicit if it is zero, which is the reference input prescribing the suppression of vibration of all harmonics. Nevertheless, it is always present in concept. A motion controller is always controlling to some prescriptive reference.

only invention of which I am aware that employs a motion controller within a stringed instrument.

This '113 patent describes separate sensing and actuating transducers attached to the wooden body of an instrument and provides an excellent discussion of adaptive control systems deployed for the purpose of altering the resonance of the body and therefore the acoustic tones emitted by the body.

It is however noted that the '113 patent does not teach motion control of the strings themselves

Ludwig does not identify the purpose or desirability of true control of vibratory motion, nor is any means of doing so presented such as using the known art of adaptive filters to achieve precise negative feedback to stabilize a feedback loop in a motion controller, much less a unitary sensing/actuating transducer motion controller as per my '059 patent.

#### Unitary Sensing/Actuating Transducer

The report states that “Ludwig also discloses at least one transducer comprises at least one sensing/actuating transducer arranged to produce the sensing signal and respond to the actuating signal during separate portions of successive time frames”, citing column 36, line 40 to column 37, line 16. I am unable to find any reference there or elsewhere that suggests this. The specific Ludwig text cited discusses instead the basic and elementary idea of acoustically coupled feedback and will be further discussed below. I cannot do otherwise than simply state that time-dividing the purpose of a single transducer between sensing and actuating, which is the essence of my previously patented '059 invention, is simply not found or even hinted at in Ludwig in any form.

### Detailed Review of the Ludwig Patent

I trust it is settled that motion control of instrument strings by unitary transducer means as per my '059 patent is not anticipated by Ludwig. I turn now to the question of whether true motion control by any other means has been anticipated in Ludwig or elsewhere.

The cited figures 20 to 26 of Ludwig progressively show in basic block form the development of the well-known topology of a feedback sustainer. These figures are discussed in Ludwig's section 2.2.3 "Vibrating Element Excitation". Nothing new is taught therein over Hoover's U.S. Patent No. 4,852,444 and especially Rose's U.S. Patent No. 5,233,123 ("123 patent") wherein the concept is given a more thorough treatment.

The use of the term "exciting or damping" in this Ludwig passage seems to suggest that damping the strings can be accomplished as easily as exciting the strings. This impression is false. The apparatus presented in the passage above and indeed in all of Ludwig will exhibit an overwhelming tendency to excite and sustain vibration. Any damping that does occur will be incidental; controlled damping invoked at will upon any chosen note of any string, impossible. This is well-known to users of controlled feedback; it's not the way to damp vibrations.

Other than in the above passage, the idea of damping, muting, suppressing, etc., vibration appears in Ludwig only in the context of mechanical means, such as in column 44 line 6 onward where a mechanical damper bar is discussed. Ludwig suggests an alternative method of controlling the amplitude of the electronic output signal, i.e. turning off the signal instead of stopping string vibration. This provides indirect evidence that damping strings through motion control was not anticipated by Ludwig.

To suppress vibration, the returned energy must be precisely and negatively aligned in frequency and phase to counter the momentum of vibration at all harmonics. If it were not so, there would have been no need for adaptive filter technology in any realm of motion control. A sustainer is like a car with no break pedal. The motion controller aspect of my invention supplies the “break pedal”.

The Ludwig specification goes on in column 36 line 64 to offer what is known to be the first elementary step in improving the reliability of sustainer action, i.e., “...The invention provides for an approach to replacing the acoustic excitation component of this process with electromagnetic excitation. FIG. 23 shows...” etc., acknowledging only Heet’s E-bow as prior art and not Rose’s ‘123 patent nor any others.

All of this is historic and well known. The problems with sustainers are not fully solved by replacing acoustic with electromagnetic excitation, but the Ludwig specification does not identify the remaining problems. Some of these problems are: the uneven amplitude of different sustained notes and strings, the inability to guarantee that the sustained note will sound at the first harmonic, (resulting sometimes in unmusical “surprises”), and the difficulty of playing the instrument because all the strings strongly tend to sustain whether the musician wants them to sound or not; he must carefully hand-mute unwanted strings at all times or bad notes will be emitted. The patents discussed below teach partial solutions. However, to the best of my knowledge only my invention provides a full solution to these problems.

See Hoover's U.S. Patent No. 4,852,444 for a discussion of sustainer system using mechanical feedback and my '473 patent filed in 1972, which teaches filters and other circuits for processing the signal before hearing it and prior to feeding the signal back through the driver.

Moore in his U.S. Patent No. 5,200,569 circa 1993 shows a similar apparatus but using electromagnetic drive. Also see Rose's '123 patent, which teaches the same concept as illustrated in Ludwig's figures 23, 25, and 26.

Regarding block 2211, Ludwig, further in section 2.2.3 says, "...electronic signal processing means 2211. FIG. 25 shows adding signal processing for spectral and amplitude control of electromagnetic excitation. For example, fixed or adaptive equalizers can be used to alter the frequency and phase response of the signal/vibration/transducer loop, permitting additional control over which vibrational harmonic(s) are emphasized in the feedback. Attenuation can be used to vary the degree of feedback. Delay can be used to alter the attack characteristics of the resonance behavior. Dynamic compressors and expanders can be used to vary the ease and dynamics of the resonance behavior. Many interesting special effects are possible...".

In this passage the term, "adaptive equalizers .... emphasized in the feedback.", may be of relevance to my invention. First I note that the purpose of the adaptive equalizers is declared in Ludwig as being to preferentially emphasize one or another harmonic, not to suppress or damp any harmonics. I note also that although phase is mentioned, it is not specified as either positive or negative. It would be a generous reading indeed to suggest that this passage teaches the idea of aligning each harmonic precisely and negatively with the motion of the string to achieve stabilized motion control, particularly since this is not declared as a goal in Ludwig. Nevertheless, the term

“adaptive” is found in the Ludwig patent. Searching within the patent for a clearer definition of ‘adaptive’ we find in column 79 at line 35 the following passage:

“FIG. 66 shows an example implementation of an adaptive method for tracking overtones for a variable-pitch vibrating element with known overtone series. The method is largely the same as the fixed-pitch case, but with some added steps. The additional steps employed are to first use a traditional pitch detector 6407 (as used with conventional MIDI guitar/violin/voice interfaces) to determine the fundamental pitch, then use this pitch information plus an overtone series model of the vibrating element 6400 to position the frequencies of the individual band-pass filters 6402.1-6402.h and amplitude followers 6403.1-6403.h.

In a preferred implementation of this approach, the detected pitch information provided by the pitch detector 6407 is fed to a model-based overtone series calculator 608. The model-based overtone series calculator 155 generates the control signals required to individually center each of the plurality of band-pass filters 6402.1-6402.h. The model-based overtone series calculator 6408 is also used to generate overtone frequency information for use in any combining or processing of the extracted overtone amplitude information and in the parameter mapping 6404 to final output control signals.”

This is the only explanation of “adaptive” that is provided within the Ludwig patent. As described, the adaptive behavior consists of tuning a series of filters according to a known harmonic series but with an offset provided “adaptively”, i.e., by measuring the pitch of the first harmonic.

The band-pass filters are centered on the overtone frequencies. This is indeed an “adaptive equalizer”, however this is not sufficient to serve as the adaptive mechanism of an adaptive control loop. Missing is a discussion of the phase relationships required to stabilize such a control loop; the concept of negative motional feedback is missing in any form, i.e., as a “correction signal”, an “error term”, etc. Also, although we are generally invited in the Ludwig patent to think of every element as being controllable by every other element, the specific connections that would constitute an adaptive control system are not diagrammed or otherwise presented.

If we are exceptionally generous in our reading of the Ludwig patent and imagine that said ‘centered band-pass filters’ are connected in a feedback loop such as that of figure 25 and if we further imagine that this feedback is negative, we still end up with an apparatus that will not suppress anything. In fact, by centering bandpass filters upon each harmonic in the feedback signal, exactly nothing is achieved in the feedback loop. A bandpass filter normally has a phase shift of zero at the center frequency. Since the string signal can contain only the expected harmonic series, nothing is being filtered out and no frequency selective phase shift is provided. The signal emerges from such an adaptive filter bank split into its partials but otherwise unchanged.

Searching further within Ludwig we do find some definite intentions for the use of this adaptive overtone tracking:

(Early in section 7.6.1.2.): “...The invention provides for an expansion of traditional synthesizer control interfaces for vibrating elements...”

“...such a feature can add tremendous control over conventional synthesizer sound production...”

The idea presented is clearly to use variations in the amplitudes of the extracted overtone series to control traditional synthesizers. This is an interesting idea, but it has no bearing upon my invention.

It is also notable that none of the papers or patents included by reference in Ludwig provides subject matter that teaches either adaptive or fixed motion control technology. In contrast, I include by reference several patents teaching adaptive motion control in my specification. See U.S. Patent Nos. 5,361,303; 5,426,720 and particularly 6,662,058 and the patents cited as references therein.

Looking further for definitions of Ludwig's signal processing block 2211, at the top of section 7.2 we find, "...Many of the audio signal processing elements cited as 125 (FIG. 1), 2211 (FIGS. 25-26), 5005.1-5005.n/k (FIGS. 51-57), and elsewhere in this document can be adequately realized by any number of the standard multi-function MIDI-controlled signal processing modules such as the Roland model RSP-550, Boss model SE-70, Ensoniq model DP/4, ART model SGE Mach-II, Digitech model GSP21..."

The Roland RSP-550 is a guitarist's effects device, now obsolete, featuring, "39 algorithms with a bandwidth of 21k, lush reverbs, delays, chorus's, stereo pitch-shifter & quad pitch shifter, phaser, flangers, rotaries, vocoder, multi-fx, mod fx, delay & verb.." and is certainly not a motion control subsystem.

The Boss SE-70 is much the same, having, "Reverb, Gate Reverb, Ambience, Delay, Chorus, Pitch Shift, Phaser, Flanger, Ring Modulator, Noise Suppressor, Overdrive/Distortion, Rotary, Enhancer, Panning/Tremolo, Slow Gear, Compressor/Limiter, Auto Wah, Guitar Amp Simulator, Vibrato, Feedbacker, [PI: This holds the note in an electronic "tape loop" to simulate a feedback

effect.], Bass Amp Simulator, De-esser, Equalizer, Vocoder, Guitar Synth, Bass Synth, Mixer, Hum Cancellor, Vocal Cancellor, Key Changer, 2 Second Digital Sampler, plus a Chromatic Tuner and Metronome.”

The other devices listed are similar. These are digital effects devices and the idea being presented here in Ludwig is that various such effects devices could be included in the feedback loop of a sustainer to achieve a variety of unspecified but possibly interesting results. One result that would certainly not be achieved would be motion control. These are not motion control subsystems. The first consequence of inserting such a device into a sustainer feedback loop would be to add about 1 millisecond of time delay due to the A/D and D/A conversion stages. This would only further destabilize any motion control system. An adaptive motion control system is not something that can be created by the haphazard connection of various devices manufactured for various other purposes – at least no sooner that those fabled 1000 randomly typing monkeys will type out the text of a coherent novel.

In figure 57 of the Ludwig patent and in the associated portions of the specifications there is given a block representation of an apparatus presented as being capable of extracting control signals from sensed pickup signals and of driving an actuating transducer with a signal that is processed through a signal processing block 5021 that is described as being responsive to control signals. (For reasons unknown, block 2211 has been replaced by a block 5021 that the specification says could be as simple as a level control.) Neither this figure 57 nor the associated text in the specification seems to add anything further beyond figures 20-26 already considered herein other than showing a mixer block. A mixer is a common element of many audio systems. In figure 57 of

Ludwig, a mixer is shown coupled to one or more sustainers. I also teach the use of a mixer, but coupled to a system having motion controllers.

Ludwig teaches 'controlled feedback' sustainer technology and enhancements thereof, as do several earlier patents. The apparatus presented in Ludwig and in blocks 2211, 5005 etc., is not sufficient for motion control having no reference input and disclosing no feedback means of stabilizing the control loop. Motion control is not presented as a goal of the Ludwig patent and no methods of achieving it are presented.

Player Techniques, Feature Extraction and Motion Control of Strings:

My invention teaches the use of player techniques to control motion control systems as a way to enhance the techniques the player already uses in the course of playing stringed instruments in a manner akin to power steering in an automobile wherein the intent to turn the wheel is sensed and a servo assists the turning. It is therefore an important aspect of my invention that specific player techniques should be properly identified and exploited so that the invention has utility.

The identification of player techniques includes as a first step the extraction of features characteristic of string vibration. The Ludwig patent does teach the extraction of pitch and overtone series from the vibrating string and derives control signals therefrom, but since Ludwig does not teach motion control, Ludwig does not anticipate the use of such control signals to govern motion controllers. Therefore the Ludwig patent does not anticipate my invention of using player techniques and feature extraction to govern the behavior of motion control systems controlling vibrating strings.

Player Techniques of Vibrato and Glissando and Control of Sustainers:

My invention discloses the identification of the specific player techniques of vibrato and glissando and their use to control not only motion control systems, but ordinary sustainer systems. Vibrato and Glissando are specific, historic and essential player techniques. The concept of measuring vibrato and or glissando and of using these extracted properties of musical signals as control signals governing the behavior of a feedback sustainer constitutes a unique and specific aspect of my invention having practical utility to musicians.

This aspect of my invention has utility because applying sustain in response to vibrato assists the musician in doing what he normally sets out to do with vibrato: To energize the sound and sustain the note more strongly. This method of player control makes existing sustainer systems more useful to musicians. These particular ideas are not present in the Ludwig specification whether expressed as such or in different equivalent terms.

As cited, in column 16, at line 24 of the Ludwig specification, reference is made to "...vibrato whammy bars...". A whammy bar is a mechanical device attached to guitars that the player operates to produce vibrato and has nothing to do with its measurement or extraction as a feature of a signal. Processor 2211 is nowhere described as a device for measuring vibrato magnitude or rate.

In Ludwig, column 49 line 54-58 has, "...audio-to-control signal extractions can be used to control synthesizers, signal processing, lighting, and special effects." Vibrato is not specified as an extraction anywhere in Ludwig. Glissando is not found in any context.

To say that Ludwig anticipates the specific invention of controlling the degree of sustain feedback excitation by a measurement of vibrato requires the reader to supply necessary ideas of method and additional details of apparatus that are not actually found in the Ludwig patent.

In contrast, my patent application not only presents these ideas specifically, but details an apparatus and algorithmic methods by which the invention can be realized in practice by one generally knowledgeable in the art of signal processing.

Thresholds:

As stated in my provisional document and this '480 application, whether there is a motion controller or a conventional sustainer for each string, it is an aspect of my invention to provide means of governing which strings receive excitation/sustain and which do not. According to my invention, a variable threshold of the weighted sum of the average amplitudes of all the strings of the instrument governs the presence or absence of sustain according to a comparison of the amplitude of each individual string signal against this threshold. This algorithm addresses the problem of governing multiple parallel sustainer activity so that unplayed strings are not actively sustained, a need that has not heretofore been identified or addressed. This particular algorithm is useful in all embodiments of the invention and is not found in the cited Ludwig patent or to the best of my knowledge in other prior art.

In the preferred embodiments of my invention that use a motion control system instead of a sustainer, the same said algorithm can cause each string to be actively damped when its amplitude falls below the variable threshold. With a conventional sustainer active damping via negative feedback is not possible so the algorithm is limited to simply reducing or cutting off the sustaining

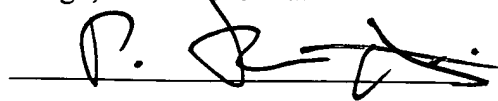
positive feedback.

Within the Ludwig patent, many (though not all), known elements and connections of musical instrument technology are collected and generalized. It does not follow that all potential results of such a collection have thereby been taught, especially when necessary details of apparatus are omitted and when such teachings is not stated as goals nor explained as methods, i.e., brought forth by Ludwig.

The particular apparatus and method set forth in my specification and the revised claims directed thereto are not to be found within the Ludwig patent nor to the best of my knowledge are they found within any publication or patent publicly available at my date of priority or indeed to this day. I respectfully request that the International Searching Authority reconsider it's conclusion that my invention is not patentable over Ludwig.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true, and further, that these statements made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or document or any registration resulting therefrom.

Signed this 28 day of February, 2006 at Raleigh, North Carolina.

A handwritten signature in black ink, appearing to read 'P. Ierymenko', written over a horizontal line.

Paul F. Ierymenko

## **Paul F. Ierymenko Career Summary**

**Present:** Owner/manager of Fiery Music llc., engaged in developing a product based on my patented and patent pending technologies.

**1994 to 2004:** Chief Technical Officer and Director of Research and Development for QSC Audio Products, Inc. Senior executive involved in all aspects of corporate planning and execution including the supervision of a staff of 40 engineers at the time of my departure.

**1980 to 1994:** Full-time design consultant and subsequently Manager of Product Design to Yorkville Sound LTD., Ontario, Canada The company's products include audio amplifiers, loudspeakers and a 24 channel digital audio mixer.

**1974 to 1989:** As owner of PFI Electronics I provided consulting product development services to several clients, chief among them were Canada Stamp and Stencil for whom I developed two digital process controllers.

**Education:** Self-educated with the help of my grandparents who had been teachers.

**Miscellaneous:** I have at times had articles published in various magazines, I've served on a few committees at the Audio Engineering Society. I am a member of the AES and the IEEE. Aside from mountain biking, my hobbies and my profession are entwined; I compose and play music and doing that I often use the products I have developed.

**Summary of my career:** As an inventor I probably run against type: I am a practical-minded person and I have developed a great many products during my career so far. I build things that actually work; I have not been regarded as a dreamer. I am pleased to say that almost every product I have developed for various clients and employers has sold well in the marketplace, some spectacularly so. I have also managed and mentored many engineers and participated in formulating successful marketing campaigns and corporate strategies. I am now bringing my experience to the challenge of developing my own products based on my life-long investigations into enhancing stringed instruments electronically.

### **Patents:**

U.S. Patent No. 6,216,059, granted April 10, 2001, entitled "Unitary Transducer Control System."

U.S. Patent No. 6,023,193, granted February 8, 2000, entitled "High Power Bridge Amplifier."

Canadian Patent No. 1017845, granted September 20, 1977, entitled "Multi-Channel Pickup with Built-In Preamplifiers."

Canadian Patent No. 1015181, granted August 9, 1977, entitled "Expanded Guitar".

U.S. Patent No. 3,813,473, granted May 28th, 1974, entitled "Electric Guitar System."